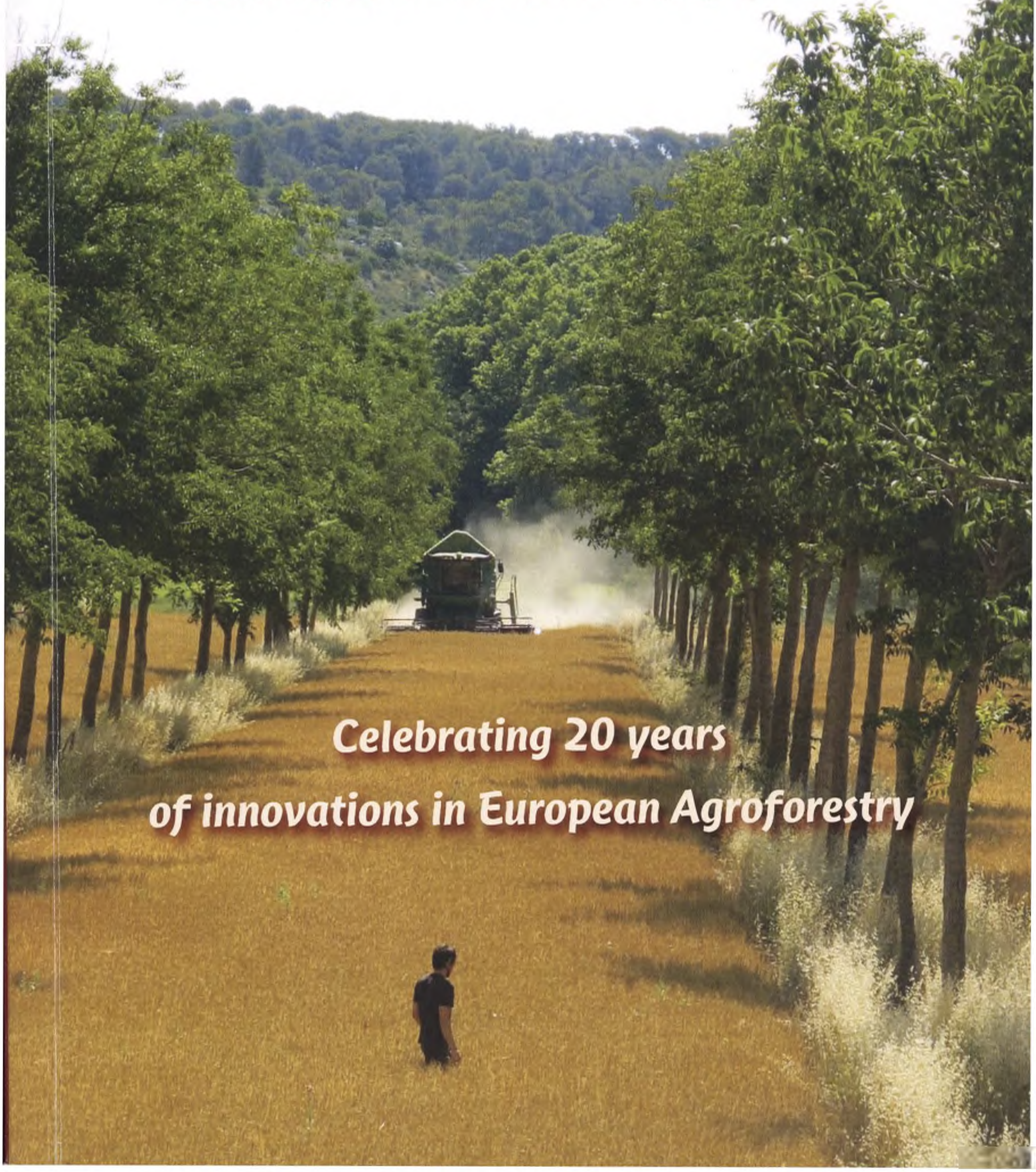
Book of Abstracts

3rd European AGROFORESTRY Conference 2016

23-25 May 2016 – Montpellier SupAgro, France



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EUROPEAN AGROFORESTRY FEDERATION

3rd European Agroforestry Conference

Celebrating 20 years of Agroforestry research in Europe

Montpellier, France, 23-25 May 2016

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INCREASE OF SOIL ORGANIC CARBON STOCK UNDER AGROFORESTRY: A SURVEY OF DIFFERENT SITES IN FRANCE

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Introduction

Soils are of crucial importance in the global carbon budget as they represent two to three times the atmospheric carbon (C) pool. Since 1850, the depletion of soil organic carbon (SOC) in cultivated lands has also contributed to about 70 Gt C to the atmosphere. It is estimated that about 70% of French agricultural topsoils are unsaturated in SOC and have thus a potential for additional SOC storage (Angers et al. 2011). Increasing SOC stocks is often seen as a win-win strategy as it allows the transfer of CO_2 from the atmosphere to the soil while enhancing soil quality and fertility (Lal 2004). Several agricultural practices enhancing SOC stocks have been identified. Agroforestry systems, i.e., agroecosystems associating trees with crops are recognized as a possible land use to maintain and increase SOC stocks. Besides producing food (or fiber) and wood, agroforestry systems may provide a variety of ecosystem services including climate change mitigation. Carbon is stored in both the tree aboveground and belowground biomass, and organic inputs from the trees could increase SOC stocks. However, few studies have assessed the impact of agroforestry systems on carbon storage in soils under temperate climates (Lorenz and Lal 2014), as most of them have been performed in tropical regions (Albrecht and Kandji 2003). Many of the available studies only report on surface soil layers while agroforestry trees can have a very deep rooting (Cardinael et al., 2015a; Mulia and Dupraz, 2006) and could thus impact deep SOC stocks. Moreover, while trees affect the spatial distribution of organic matter inputs to the soil, the potential impact on the spatial distribution of SOC stocks is not always taken into account in sampling protocols. The objectives of this study were i) to quantify organic carbon stocks in soils and in tree biomass in agroforestry systems and in adjacent agricultural control under different soil and climate conditions in France, and ii) to estimate SOC accumulation rates for these systems.

Methods

This study was conducted in five silvoarable agroforestry systems and in one silvopastoral system in France (**Figure 1**). All sites included an agroforestry system and an adjacent agricultural control plot. Soil texture was determined at all sites in both the agroforestry and the control plots to make sure soil characteristics were the same. In all cases, crop and soil management in the agroforestry inter-rows and in the control plot were strictly the same. The ages of the study sites ranged from 6 to 41 years since the tree planting. Our sampling protocol was defined to take into account for possible heterogeneities in the spatial distribution of SOC stocks due to the presence of trees and tree rows, with sampling points taken at varying distances from the trees. Maximum sampling depth ranged from 20 to 100 cm, and soil samples were taken every 10 cm depth using a 500-cm^3 cylinder. SOC stocks were measured on an equivalent soil mass basis (Ellert and Bettany 1995). Tree aboveground biomass was also measured at all sites.

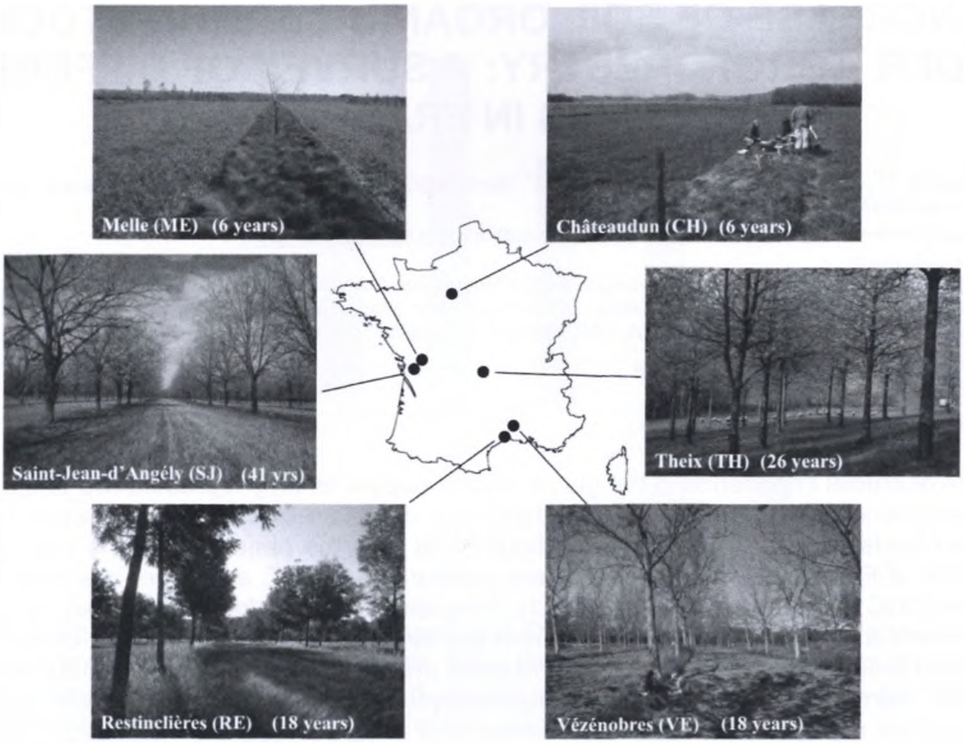

Figure 1: Location of the six agroforestry systems sampled in France (Cardinael et al., under review).

Results

In silvoarable systems, the mean SOC accumulation rate was 0.24 (0.09-0.46) Mg C ha^{-1} yr^{-1} at 0-30 cm depth (**Figure 2**) (Cardinael et al., under review). Additional SOC storage was also found in deeper soil layers at the oldest sites (Cardinael et al. 2015b). . Trees rows had an important impact on SOC storage, contributing up to 50% of additional SOC storage at the silvoarable plot scale while only representing a small surface area. Young plantations also stored SOC but mainly in the tree rows and we suggested that the herbaceous vegetation growing in the tree rows was a key factor. In the silvopastoral system, additional storage was only found below 40 cm depth. The mean carbon stocks in the aboveground biomass was about 16 (0.02-36.69) Mg C ha^{-1} for all sites. Additional SOC between the agroforestry and the control plot was correlated to the age since the tree planting and to soil clay content.

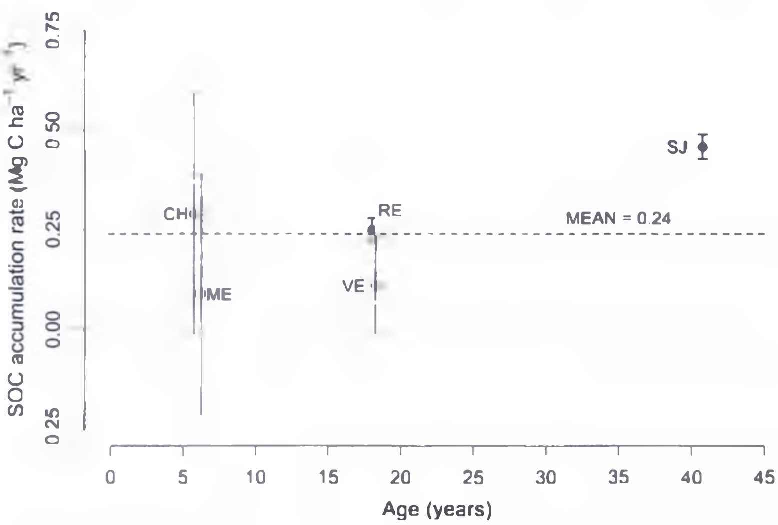

Figure 2: SOC accumulation rates as a function of plantation age. Values are for approximate 0-30 cm, except for the SJ site (0-20 cm, maximum soil depth) (Cardinael et al., under review).

Discussion and conclusion

All together our study demonstrated the potential of agroforestry systems to store SOC in temperate regions, making this practice an interesting tool to help climate change mitigation through agriculture. Compared to other practices enhancing SOC stocks, agroforestry systems showed a potential to increase SOC below 30 cm as well as storing C in woody products. It also pleads for implementation of long-term and diachronic agroforestry trials in order to estimate more accurately SOC storage potentialities, especially in deep soil layers and in old plantations where data are lacking.

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